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Common factors and major characteristics of household energy consumption in comparatively well-off rural China

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Abstract

Common factors that influence Chinese rural household energy consumption are proposed and major demand characteristics of well-off rural areas are analyzed on the basis of survey data. A system of major characteristic indicators for rural household energy consumption includes effective heat consumption for livelihood per capita per day (EHC), the proportion of commercial energy in EHC (PCE) and annual electricity consumption for livelihood per capita (AEC). Typical values in three economic regions (out-of-poverty, well-off and rich areas) of China are also given.

Keywords: Energy utilization; Energy planning; Rural areas; Biomass; Fuels

Contents

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1. Introduction

Energy provision in rural areas is a common problem for all developing countries, including China. For a long time, commercial energy requirements in rural China were barely satisfied and supply has been unstable. Household energy consumption mainly depends on biomass and other local natural resources; the energy-conversion efficiency is low due to obsolete technology and facilities [9].

Energy supply and consumption in rural areas has become a common focus for analyses in less developed countries since the world energy crisis in the 1970s because it directly effects sustainable and balanced economic development. Large quantities of renewable energy resources, such as firewood and straw, are used in the countryside. However, more commercial energy will inevitably be required in rural areas to meet the energy demands of rural economic development [2].

Rural household energy consumption has become a major focus of concern in all developing countries. On one hand, rural household fuel consumption constitutes the majority of total national energy consumption in many developing countries; on the other hand, the social and economic costs of household fuel to the rural poor are high and rising rapidly. By UNDP and World Bank's estimate based on investigations in 15 countries, household energy consumption covers 30–95% of the total energy consumption in developing countries (compared with 25–30% in developed countries) and the poorer the country, the higher the share. Many households depend mainly, or even exclusively, on biomass fuels [3]. With the reduction of biomass resources in many regions, those rural families relying on biomass fuels must spend more time and energy to obtain the bare necessities of fuel. This increases stress on already fragile household survival. Thus, the significance of studying the household energy consumption in rural areas goes beyond energy itself. No great change is expected to occur in the long term in the structure of household energy consumption and the dependence on biomass in rural areas [10].

Large-scale studies on rural household energy consumption started from the middle of the 1970s in China. An investigation in 1979 showed that 47.7% of rural households did not have enough fuel for 3–6 months and the national ratio of energy supply to demand was 78% [1,5]. A study at the end of the 1980s showed that there are large differences among regions, depending upon locality and availability of fuels. Energy consumption per household accounts for 700–1200 kgce (kilogram of coal equivalent), 40–60% of which is used for cooking. Biomass accounts for 60–90% of the total household energy consumption. The average

energy conversion efficiency using biomass fuels is in the range 10–20%. Where the strain of traditional patterns of biomass use on the resource base has become too severe, the traditional balance of the local agricultural and hillside ecosystem has unraveled [6,7]. This causes accelerating destruction of the already limited land resources upon which the livelihood of the rural population depends. It was found that higher income households have more commercial energy use, especially electricity. In the future, however, rural household energy consumption will continue to rely mainly on biomass [8].

Changes have taken place in household energy consumption in well-off or moderately well-off areas where rapid economic and social development is occurring. It is important to understand the basic pattern of the changes for the enactment of energy policies and the balance of energy production and consumption in China, which is still a developing country with large rural populations depending on local natural resources. In this paper, major characteristics of household energy use in well-off areas are analyzed. The results of a household survey conducted in Yangzhong County in Jiangsu Province (a well-off rural area) are used to calculate common indicators of rural household energy consumption. Typical values of major indicators for households of different economic type are presented within the framework of an indicator system of household energy consumption.

2. Common factors reflected on rural household energy consumption

Both similarities and differences exist in household energy and other consumption patterns in rural areas. Energy consumption is mainly for the necessities of life, but also for higher quality living amenities including comfort, convenience, and sanitation. No payment in cash is needed for locally available biomass energy sources (straw, firewood, etc.), but households must pay cash for commercial energy sources (electricity, LPG, coal, etc.). For many years, most households in rural areas of China depended mainly on biomass energy sources, while commercial energy consumption was only for households with high financial status and with access to commercial energy.

There are some common factors that reflected on rural household energy consumption. Generally, the common factors include feasibility, multi-source, substitutability, income stratum, variability and symbolization.

2.1. Feasibility

Feasibility of rural household energy consumption refers to local conditions of resources, economy, living conditions and energy supply, which determine the feasible level and stability of per capita energy consumption.

2.2. Multi-source

The multi-source structure of energy demand means that several different sources may be used to produce a certain level of effective energy consumption. The sour-

ces used may vary greatly across different areas due to differences in income and the availability of different sources.

2.3. Substitutability

Substitutability of some energy sources can ensure certain effective energy demand is met when one energy source in shortage is replaced by another one. The substitution of lower quality energy sources by higher quality ones, which is generally non-reversible, accompanies improvements in living conditions.

2.4. Stratum

Variations in energy consumption patterns exist across households of different income strata. Household energy sources selection are limited by household financial situation and urgency for energy demand.

2.5. Variability

Variability of household energy consumption refers to the ability of households to adjust their energy consumption level with changes in the scarcity or cost of energy. This is achieved through modification of their energy consumption behavior and a certain variation in effectiveness of household energy application. When the cost of a certain local natural energy source is very low, it is inevitable that excessive use of this energy source will take place and the consumption will exceed its sustainable supply.

2.6. Symbolization

Symbolization refers to the psychological factor in energy demand. With rising income, households may wish to show their higher social status through using high quality energy sources for more comfortable living conditions.

The common qualities of rural household energy consumption result in major characteristics varying across different economic development stages.

3. Major characteristics of well-off rural household energy consumption

Because of its large area and big differences in social and economic conditions and living styles, China's rural household energy consumption pattern and levels vary considerably across regions. Objectively it is necessary to take these differences into consideration when analyzing the generality of each stage of rural household energy consumption.

As the economy develops and commercial energy consumption increases, rising incomes play a more important role in the rural energy consumption pattern and level. For the purpose of our study, rural areas were divided into three types: out-of-poverty, well-off and rich. According to the net income per capita per year, the three types are out-of-poverty (<RMB1940), well-off (RMB1941–4000) and rich (>RMB4000). Well-off living standards are a step beyond satisfying only living

necessities, so energy consumption must be suited in quality and quantity to the improvement of means of livelihood, with abundant food, clothing, comfortable housing conditions and other living amenities, although still not at the highest level of affluence.

The major trends of well-off rural household energy consumption lie in the rapid increase of high quality energy sources demanded (mainly electricity and LPG) and replacement of large amount of traditional energy sources. Effective energy consumption has increased due to the change of energy structure, though average household per capita energy consumption is stable.

Rural household energy consumption depends on both demand and supply factors. Energy demands in the well-off countryside increases in accordance with the improvement of living standard, while at the same time the ability to meet rising demands is affected by the stability of the rural energy market—that is, reasonable prices and ready availability. The rapid growth in consumption of electricity and LPG by high income farmers is made possible by the reconstruction of rural electricity networks, improvement of electricity supply reliability and LGP exchange market in rural areas.

4. Major characteristic indicators and their values on rural household energy consumption in China

The major characteristic indicators for evaluation of regional variation in rural household energy consumption includes three principal measures: effective heat consumption for livelihood per capita per day (EHC); proportion of commercial energy in EHC (PCE), and annual electricity consumption for livelihood per capita (AEC).

EHC is a quantitative indicator for households' effective energy consumption, indicating the actual consumption of effective heat in cooking, water heating, pig feed heating, etc. This index does not include the effective requirements of room heating in winter and air conditioner (electricity consumption by air conditioner is included in the index of AEC), so as to eliminate the influence of climate factor to compare the volumes of this index in different areas. PCE reflects the structural changes of energy resources with growing income. AEC indicates the level of living comfort.

The values of characteristic indices of rural household energy consumption on Yangzhong County in Jiangsu Province is given in Table 1. EHC is stable, but there was a rapid increase in the ratio of commercial energy, especially LPG, and per capita electricity consumption over 5 years (1992–1996).

Ratios of commercial energy expenditure to net income over 5 years, as shown in Table 2, did not increase (even decreased) with increasing income. The declines in ratio are mostly small, however, which means that commercial energy consumption will not be reduced by rising incomes.

The recent values of characteristic indicators of rural household energy consumption in Jiangsu, Zhejiang and Shandong Provinces are given in Table 3. While

Table 1
The values of characteristic indices of rural household energy consumption on Yangzhong County in Jiangsu Province (per capita)

	Net income (RMB)	EHC (kcal)	PCE (%)	Ratio of LPG in EHC (%)	AEC (kWh)
1992	1661	1447.0	21.9	2.8	90.10
1993	2455	1283.2	26.7	8.3	106.98
1994	3388	1091.6	20.1	10.1	109.69
1995	4023	1134.6	32.0	21.6	130.60
1996	4414	1217.0	42.2	31.2	137.48

Agricultural Engineering College of Nanjing Agricultural University [7].

Table 2
Per capita cash to buy commercial energy on Yangzhong County in Jiangsu Province

	Per capita cash expense (RMB)	Ratio of cash expense to net income (%)
1992	83.10	5.0
1993	108.11	4.4
1994	91.50	2.7
1995	128.48	3.2
1996	159.57	3.6

Agricultural Engineering College of Nanjing Agricultural University [7].

Table 3
The values of characteristic indices of rural household energy consumption in three provinces (per capita)

	Net income (RMB)	EHC (kcal)	PCE (%)	AEC (kWh)
Jiangsu (1997)[a]	3270	1279	27.5	97.0
Zhejiang (1994)[b]	2225	1172	24.2	96.5
Shandong (1995)[b]	1715	1263	20.4	71.5

[a] Agricultural Engineering College of Nanjing Agricultural University [7].
[b] Ref [4].

all three provinces enjoy a well-off living standard, significant differences across the three areas are shown from the indicator values.

Studies have shown that the average rural household needs 4500 kcal (1.88×10^7 J/day) of effective heat per day per household (1125 kcal per capita) [7] (not including heat requirement for room heating in winter). Therefore, this value was taken as a standard for division between out-of poverty and well-off families. For well-off families, the growth of effective energy requirement is mainly caused by cooking and water heating due to higher living standards.

One of the characteristics of well-off household energy consumption is rapid growth of high quality commercial energy (mainly electricity and LPG). LPG stoves are popular in most well-off families, and the ratio of commercial energy in total effective heat consumption accounts for over 20%. However, non-commercial

Table 4
Typical values of characteristic indices of energy consumption for different types of rural regions

Characteristic indices	Out-of-poverty region	Well-off region	Richer region
EHC (MJ)	<4.61 (1100 kcal)	4.61–5.44 (1100–1300 kcal)	>5.44 (1300 kcal)
PCE (%)	<20	20-50	>50
AEC (kWh)	<70	70-150	>150

energy is still the major energy resource for well-off households. Therefore, the distinction between well-off and rich regions will be marked by whether the commercial energy consumption in EHC accounts for over 50%.

Electricity consumption is related to how many home appliances are used. Electricity is consumed mainly for lighting, electric fan and television for out-of-poverty households, with only 70 kWh of electricity consumption per year per capita. Color TV, washing machine, electric cooking utensils, refrigerator and air conditioner are used by well-off families, resulting in higher electricity consumption (70–150 kWh per year per capita). Refrigerators and air conditioners are popular in rich families, causing much higher electricity consumption.

Therefore, the typical values of characteristics indicators of energy consumption by households in rural regions in different economic stage are given in Table 4. The typical values of characteristics indicators are used in determining reasonable energy consumption in different types of rural households, which provide useful references for energy forecasting and planning in the rural economic and social developments.

5. Conclusion

Chinese rural household energy consumption is entering a new period with rapid economic and social development in rural areas. The common factors that reflected on rural household energy consumption consist of feasibility, multi-source, substitutability, stratum, variability and symbolization, which can be shown from many aspects. The complex influences among different qualities determines the major characteristics of Chinese rural household energy consumption. In the period under study, the major trends in rural energy consumption by well-off households lie in the rapid increase in high-quality commercial energy demand, typically electricity and LPG. The average efficiency of energy consumption increased slightly, while average energy consumption per capita remained stable.

Multiple indicators are used in the evaluation of household energy consumption. The evaluation system is comprised of effective heat consumption for livelihood per capita per day, the ratio of commercial energy in EHC, annual electricity consumption for livelihood per capita, which can reflect the major characteristics of rural household energy consumption in full scale. According to the basic status of Chinese rural economy, the three indicators range from 1100–1300 kcal, 20–50% and 70–150 kWh, respectively, for well-off rural areas. These indicators are used in

determining reasonable energy consumption in different types of rural households, which provide useful references for energy forecasting and planning in the rural economic and social developments.

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